



U.S. Department of Energy
Energy Efficiency and Renewable Energy

DATA CENTER ENERGY EFFICIENCY TRAINING

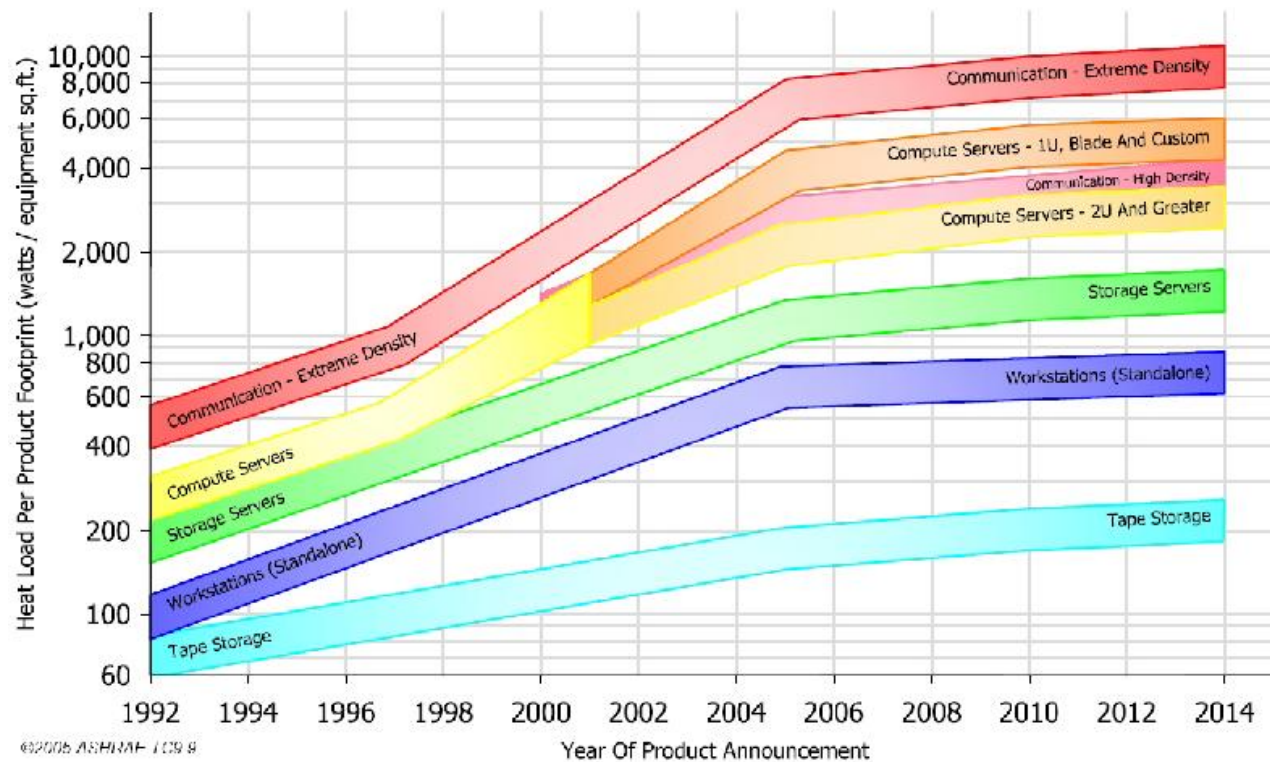
IT Equipment/Software



<Presenter>



ASHRAE prediction of heat density





IT equipment load

- Predicting IT loads
 - Over sizing, at least initially, is common
 - Implement modular and scalable approaches
- IT loads can be controlled
 - Power supply options
 - Server efficiency
 - Software efficiency (Virtualization, MAID, etc.)
 - Redundancy and back-up power
 - Low power modes
- Reducing IT load has a multiplier effect



The value of one Watt saved at the server CPU

1 Watt at CPU

= 1.25 Watts at entry to server (80% efficient power supply)

= 1.56 Watts at entry to UPS (80% efficient power supply)

= 2.5 Watts including cooling (1.6 PUE)

= 21.9 kWh per year

= \$2.19 per year (assuming \$0.10/kWh)

= \$6 of infrastructure cost (assuming \$6/W)

• **Total Cost of Ownership (TCO) Perspective = \$12.60**
(assuming three year life of server)

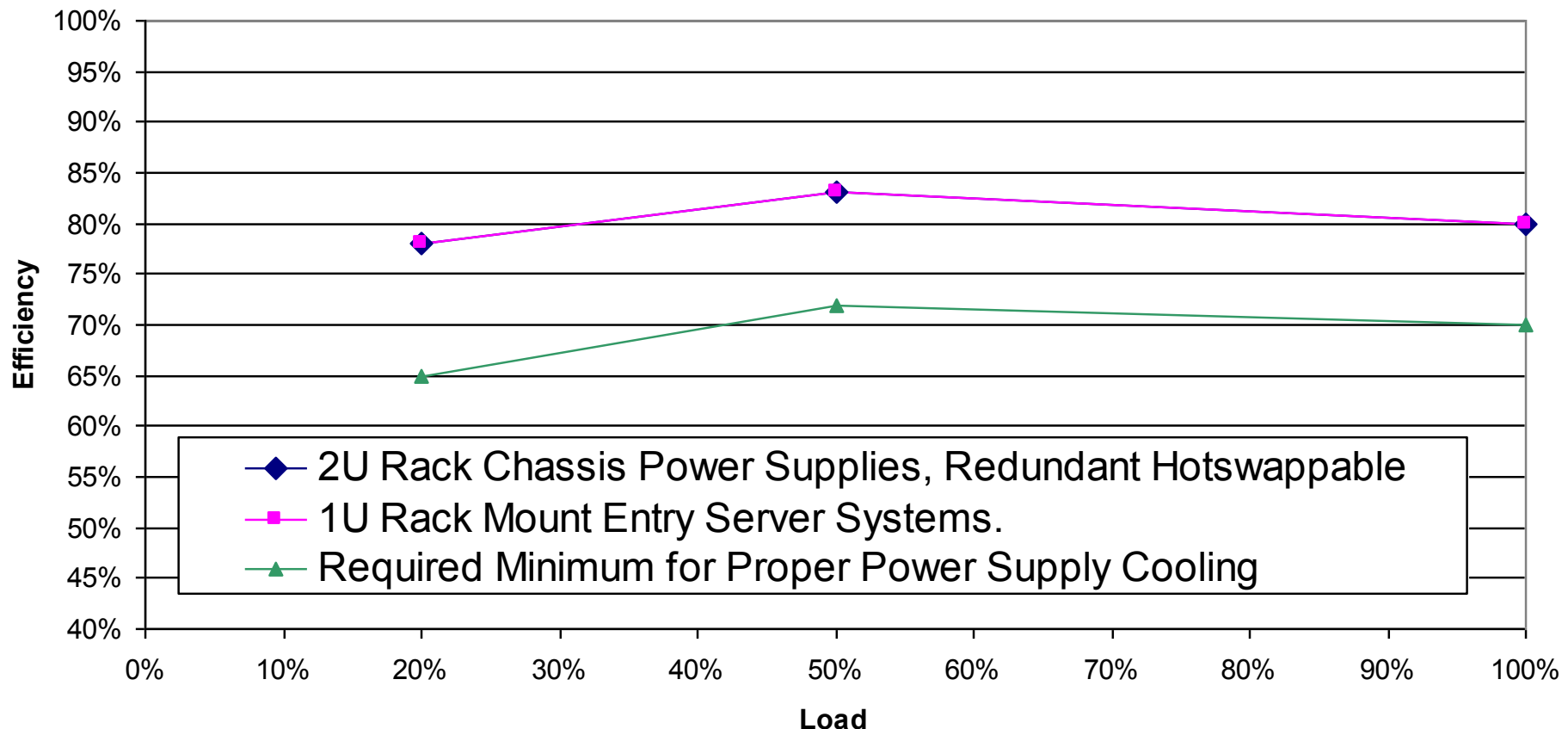
• **Typical added cost of 80 plus power supply \$3 - \$5.**

• **Typical value - \$168** (assumes 15 Watts saved at power supply not CPU)



Efficient power supplies

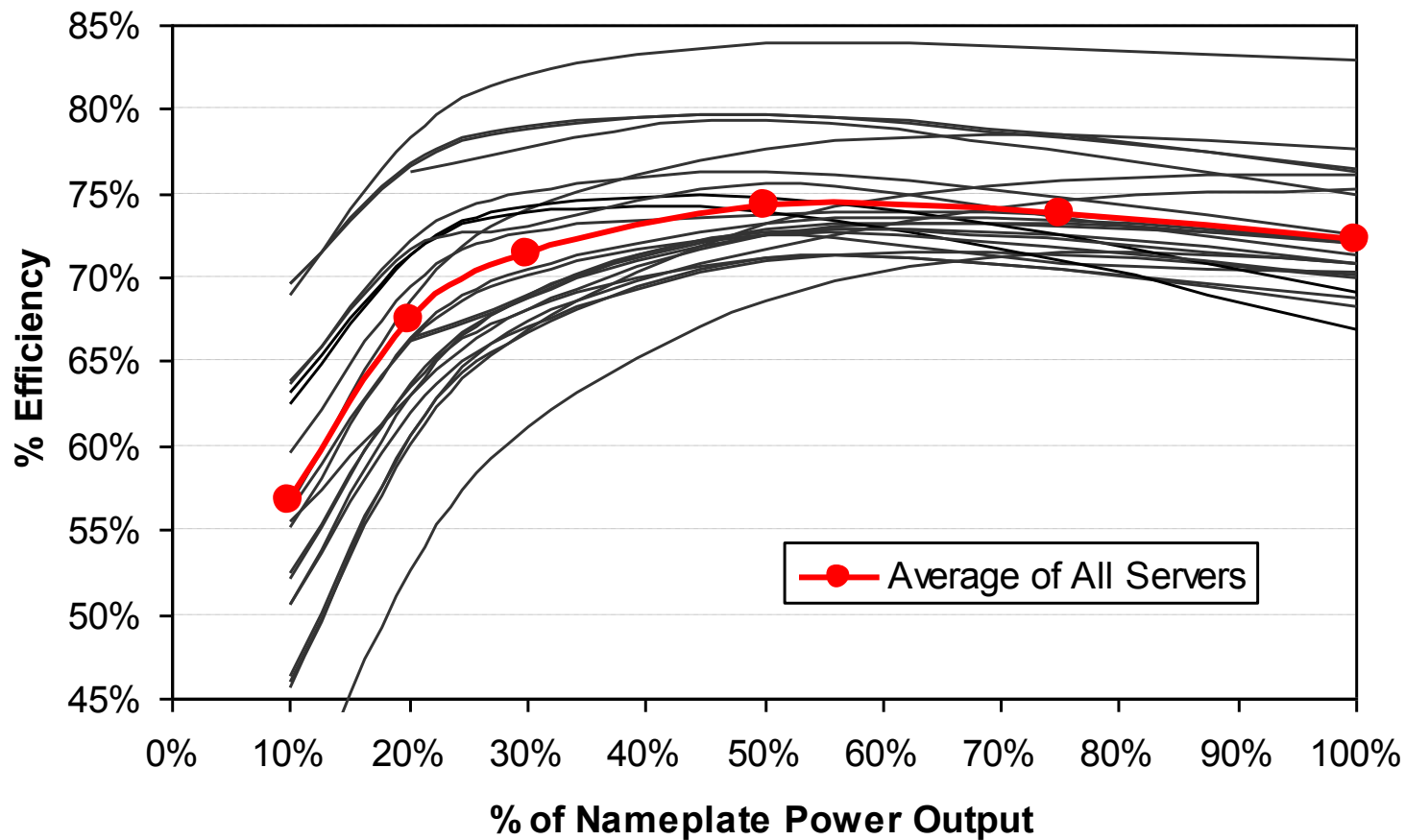
SSI Recommended Minimum Power Supply Efficiencies



Server System Infrastructure (SSI) Initiative (SSI members include Dell, Intel, and IBM)



Measured power supply efficiency





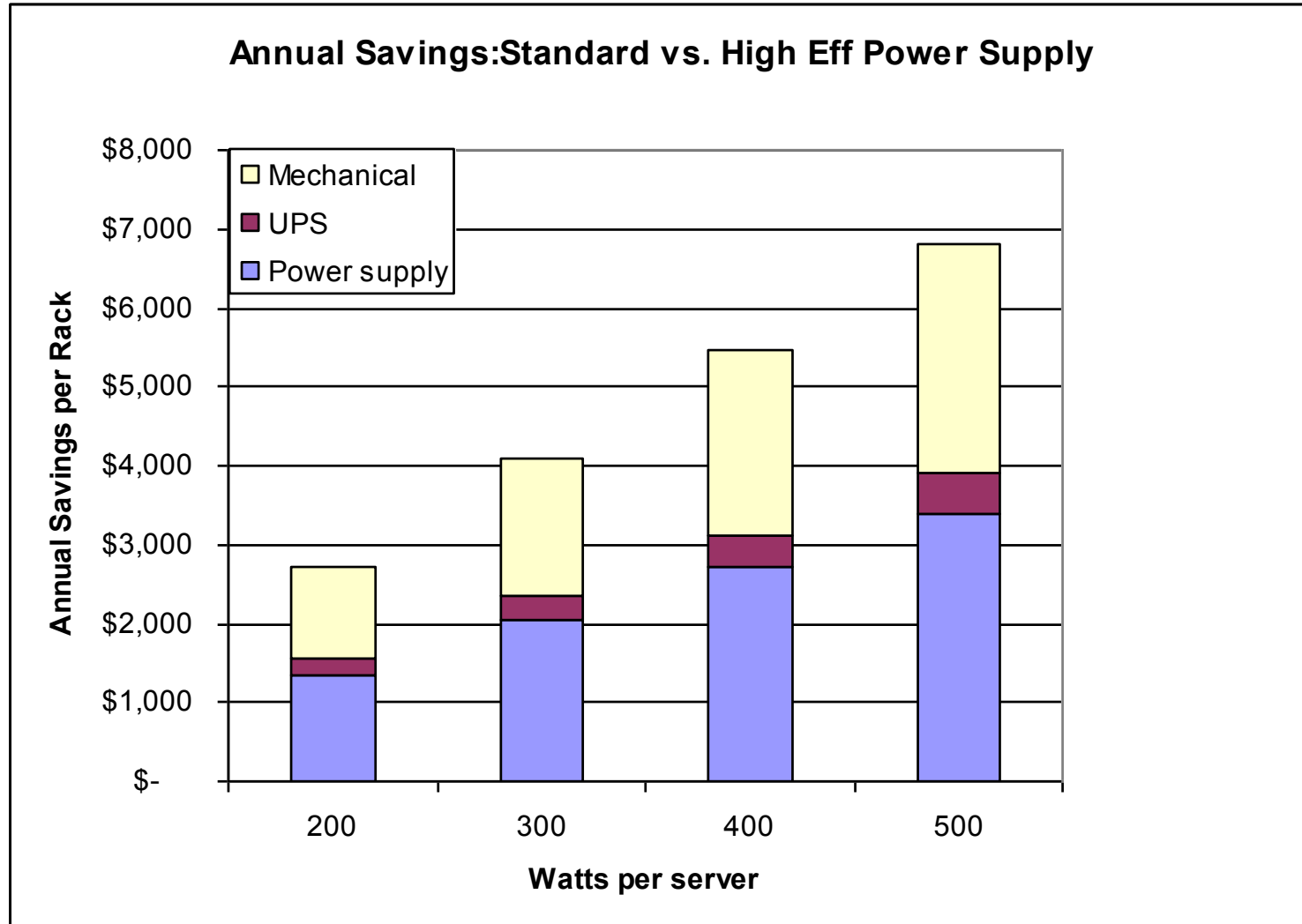
Power supply, per server savings

Power Supplied Per Server (Watts)	Annual Savings Using a SSI Recommended Minimum Efficiency Supply ¹	Annual Savings Including Typical Cooling Energy ²
200	\$ 37	\$ 65
300	\$ 56	\$ 97
400	\$ 74	\$ 130
500	\$ 93	\$ 162

- 1. Assuming \$0.10/kWh, 8760 hr/yr, 85% efficient UPS supply, 72% efficiency baseline PS
- 2. Cooling electrical demand is estimated 75% of rack demand, the average ratio of 12 benchmarked datacenter facilities



Power supply savings add up





Resources

Server System Infrastructure

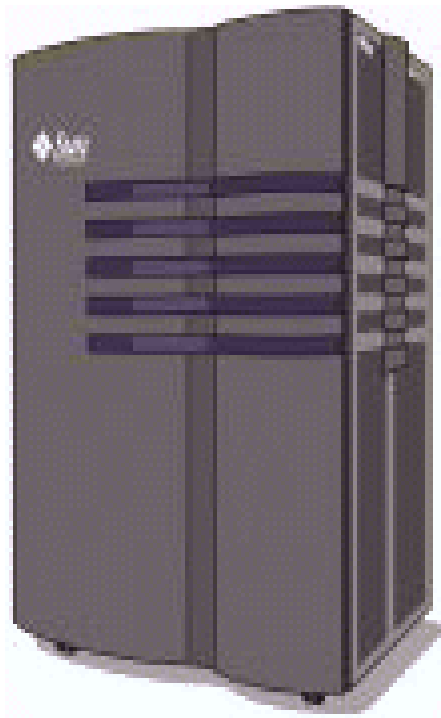
Managing Component Interfaces

- www.ssitorums.org
- www.80plus.org





High Efficiency Servers: Sun Example



1997 – 2001

**32 x Ultra Sparc2
Processors**

**77.4 ft³
2,000 lbs**

**\$200,000 to
\$400,000**

**13,456 W
52,000 BTUs/hr**



2005

**1 x UltraSparc T1
Processor (8 Core)**

**0.85 ft³
37 lbs**

\$20,000

**~300 W
1,364 BTUs/hr**



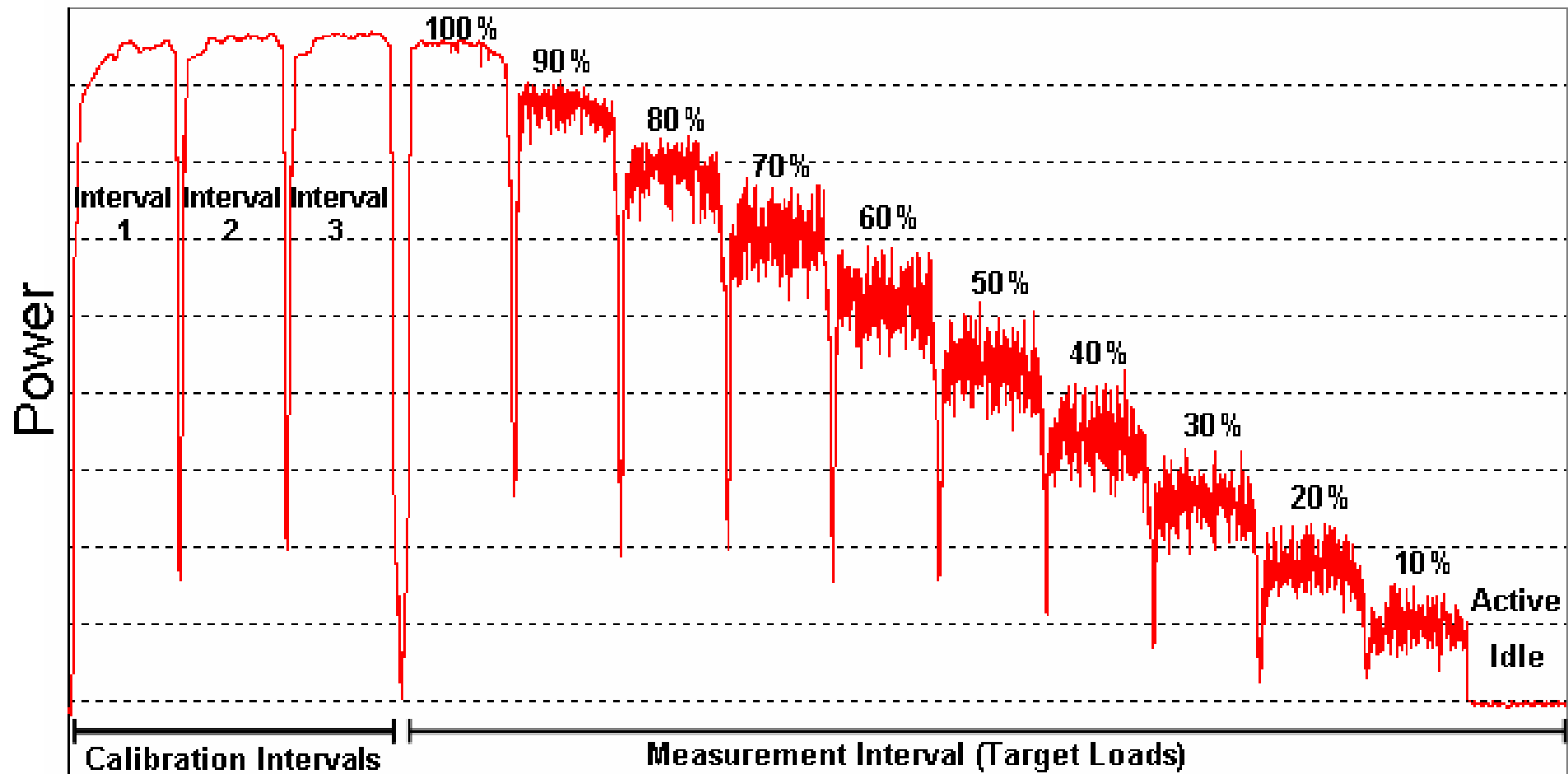
High efficiency servers

Energy savings and PG&E incentive for installation of three new High Efficiency Servers.

	Baseline Usage	Installed Usage	Energy Savings	Electric Cost Savings	PG&E Incentive	Incremental Installation Cost
	kWh/yr	kWh/yr	kWh/yr	\$/yr	\$	\$
Install High Efficiency Servers - Direct Energy Savings	24,538	4,941	19,598	\$ 2,352	\$ 1,960	n/a
Install High Efficiency Servers - Indirect HVAC Savings	9,003	1,813	7,190	\$ 863	\$ 1,007	n/a
Combined	33,541	6,753	26,788	\$ 3,215	\$ 2,967	n/a



Coming soon - power performance metrics e.g. Standard Performance Evaluation Corp (SPEC) SPECpower Workload Iteration



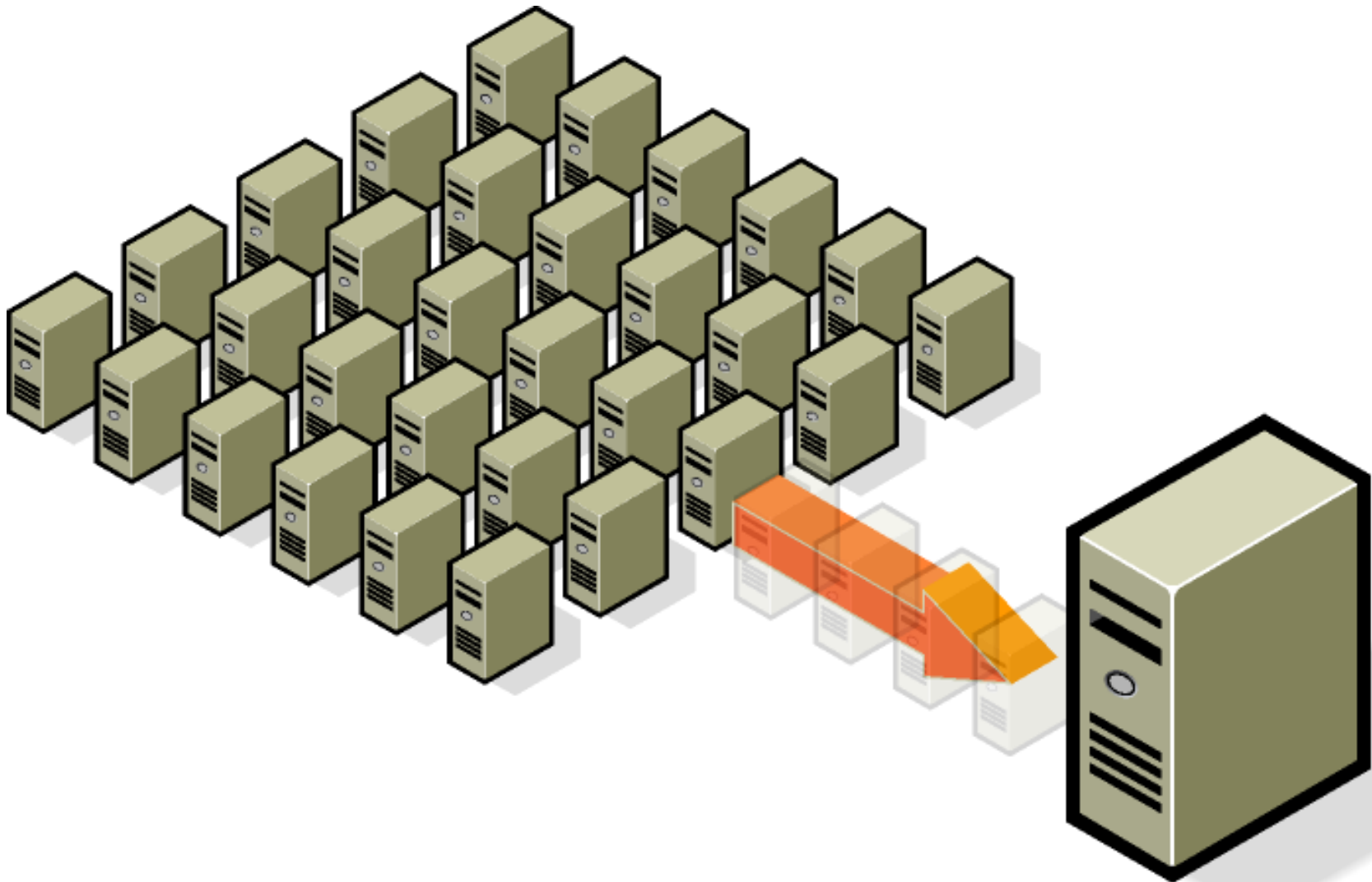


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IT Equipment/Software

Server virtualization





Server virtualization

- Energy savings and PG&E incentive for Server Virtualization.
- Number of servers before virtualization: 50.
- Number of servers after virtualization: 30.

	Baseline Usage	Installed Usage	Energy Savings	Electric Cost Savings	PG&E Incentive	Total Installation Cost
	kWh/yr	kWh/yr	kWh/yr	\$/yr	\$	\$
Install Virtual Server - Direct Energy Savings	98,550	59,130	39,420	\$ 4,730	\$ 3,154	\$ 70,000
Install Virtual Server - Indirect Equipment Support Savings	60,636	36,382	24,254	\$ 2,911	\$ -	\$ -
Combined	159,186	95,512	63,674	\$ 7,641	\$ 3,154	\$ 70,000



Thin clients

- Typical Desktop Computer, 75 – 100 Watts, \$500
- Typical Laptop Computer, 10 – 15 Watts, \$1,000
- Typical Thin Client, 4 – 6 Watts, \$300





Thin clients

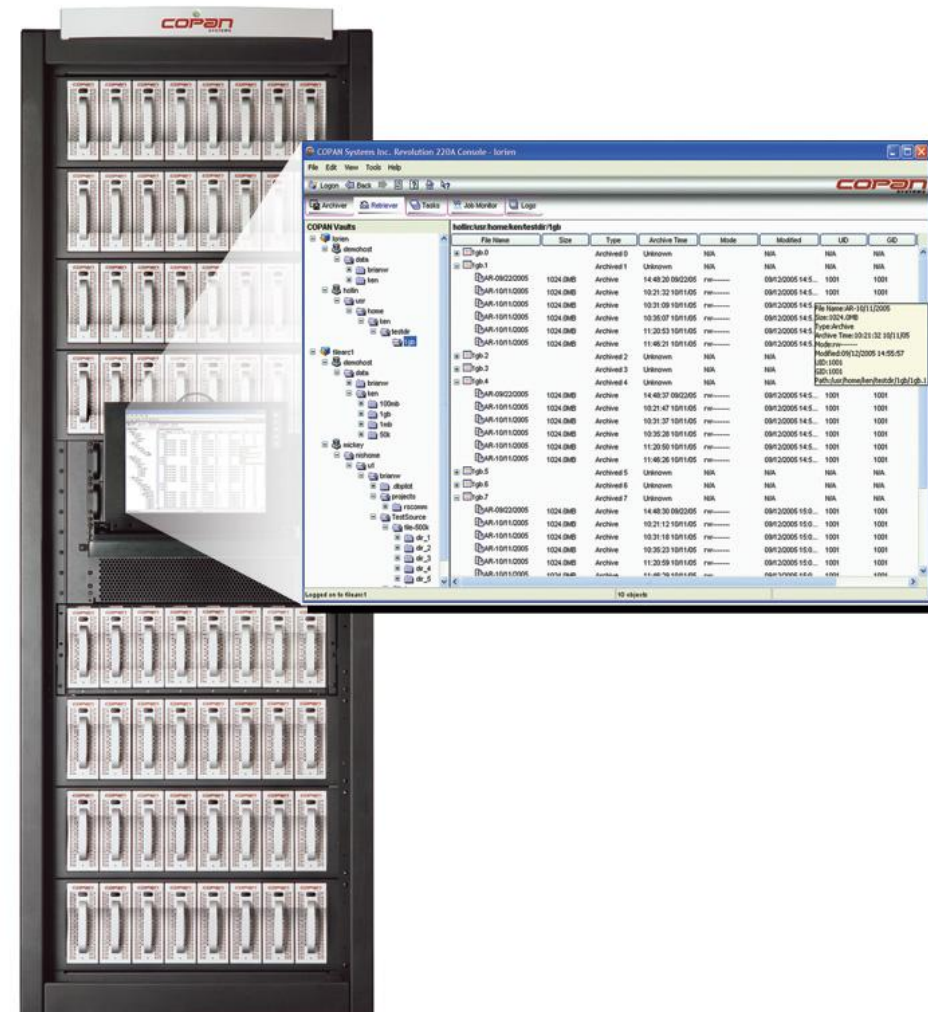
- Energy savings and PG&E incentive for implementation of a Thin Client network.
- Replace 50 generic workstations with 50 Thin Client terminals.

	Baseline Usage	Installed Usage	Energy Savings	Electric Cost Savings	PG&E Incentive	Total Installation Cost
	kWh/yr	kWh/yr	kWh/yr	\$/yr	\$	\$
Install Thin Client Computers - Direct Energy Savings	35,040	15,626	19,414	\$ 2,330	\$ 1,553	\$ 25,000
Install Virtual Server - Indirect HVAC Savings	12,856	5,733	7,123	\$ 855	\$ -	\$ -
Combined	47,896	21,359	26,537	\$ 3,184	\$ 1,553	\$ 25,000



Massive array of idle disks (MAID)

- MAID is designed for Write Once, Read Occasionally (WORO) applications.
- In a MAID each drive is only spun up on demand as needed to access the data stored on that drive.





Massive array of idle disks (MAID)

- Energy savings and PG&E incentive for installation of a MAID system.
- Install one fully-loaded MAID cabinet with a total storage capacity of 448TB in lieu of a traditional cabinet of the same capacity.

	Baseline Usage	Installed Usage	Energy Savings	Electric Cost Savings	PG&E Incentive	Incremental Installation Cost
	kWh/yr	kWh/yr	kWh/yr	\$/yr	\$	\$
Install Maid System - Direct Energy Savings	278,450	75,118	203,332	\$ 26,551	\$ 16,267	\$ 224,000
Install Maid System - Indirect HVAC Savings	102,163	27,561	74,602	\$ 9,742	\$ 10,444	\$ -
Combined	380,613	102,679	277,934	\$ 36,293	\$ 26,711	\$ 224,000



What's the server airflow?

	SUN	SUN	DELL	DELL
	V490	V240	2850	6850
num fans	9	3	n/a	n/a
total CFM (max)	150	55.65	42	185
total CFM (min)			27	126
fan speed	single speed	variable	2 speed	2 speed
fan control	n/a	inlet temp.	77F inlet	77F inlet
Form Factor (in U's)	5	2	2	4
heat min config (btuh)		798		454
heat max config (btuh)	5,459	1,639	2,222	4,236
heat max (watts)	1,599	480	651	1,241
dT min config	-	13	-	3
dT max config	33	27	48	21
servers per rack	8	21	21	10
CFM/rack (hi inlet temp)	1,200	1,169	882	1,850
CFM/rack (low inlet temp)	1,200		567	1,260
max load / rack (kW)	13	10	14	12



Best Practices and IT Equipment

- Power supply efficiency
- Standby/sleep power modes
- IT equipment fans
- Virtualization
- Load shifting



IT take aways

- Efficient power supplies have large annual savings
- Efficient power supplies reduce infrastructure power consumption
- Efficient servers are orders of magnitude more efficient than older equipment
- CA public utilities incentives are available
- Virtualization can eliminate many servers
- Thin clients are economical and great energy savers
- Software to limit spinning discs has large promise
- Saving one watt at the server saves 2.5 watts overall



Airflow design disjoint

- IT departments select servers and racks – each having airflow requirements
- Engineers size the facility fans and cooling capacity
- What's missing in this picture?

